FOREST PEST MANAGEMENT
Pacific Southwest Region

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3420

Causes Of Tree Mortality In Pine Plantations Within the Cleveland Fire, Eldorado National Forest

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Introduction

Three sites burned by the 1992 Cleveland Fire on the Pacific Ranger District, Eldorado National Forest were examined on July 2, 2002. Those present included Bob Carroll, District Silviculturist, and John Pronos, Forest Health Protection (FHP) plant pathologist from Sonora. Small pockets of recent ponderosa pine mortality had become apparent, and the purpose of this visit was to identify the probable causes of mortality and determine if any change in management was warranted.

Observations

Each of the areas we visited had been planted in 1993 or 1995. Chemical release treatments were completed in 1995, 1996 and again in the spring of 2002 (Stop 1 only). Ground cover included abundant grass, common brush species such as manzanita and ceanothus, plus spouting black and live oaks. These treatments were apparently successful and competition from brush did not seem to be a significant factor. All of the trees that had died were those planted after the fire and most of them died in 2001, prior to the latest release.

Stop 1: This site was on a steep, south-facing slope at an elevation of approximately 4000 feet. Of the three sites, this was the harshest. Several dozen trees scattered over about 10 acres had died within the past year. We excavated a few dead pines and in the process noted that the soil was very dry and rocky. No root disease pathogens were found on the roots, and no evidence of insect activity on the boles or branches was observed. However, all but one of the excavated pines had poorly formed or defective root systems. Defects included small and constricted root systems, "J" roots and roots growing appressed to rocks.

Stop 2 was at a location with the best site quality of the three stops as evidenced by the larger planted pines. Only a few dead trees were present. The soil was removed from around the bases of two recently killed pines. Fresh and active mycelial fans of the root disease fungus *Armillaria mellea* were found in and under the bark. (Refer to the description of pathogen biologies at the end of this report). Both dead pines were within 20 feet of a vigorously sprouting California black oak. The oak sprouts were all less than 3 inches DBH, and presumably originated after the 1992 wildfire.

Stop 3 was just above a paved road where pine stumps were more numerous while black oak stumps/sprouts were less abundant and brush was minimal. A few scattered dead planted pines that probably died in 2001 were present. No evidence of Armillaria was found, so samples of wood and bark from the base of the two trees were taken back to Sonora. Here the samples were placed in plastic bags with moistened paper towels and incubated in the dark at room temperature for 8 days. At the end of 8 days the samples were examined with a dissecting microscope and were found to contain fruiting structures of the asexual stage of *Heterobasidion annosum* (annosus root disease).

Discussion and Implications For Management

Three different factors are currently contributing to mortality of planted pines within the Cleveland Fire. The District has already begun thinning some plantations to their final spacing, and the question is whether to continue this if additional mortality from pests and other factors is going to occur.

There are likely to be future tree losses from each of the 3 mortality agents found. Local precipitation was mostly above normal from 1996 to 2000, but only 64% of normal in 2001 (based on Sacramento Municipal Utility District records from nearby Fresh Pond, CA), which may have contributed to the mortality at sites like Stop 1 where the soil is poor and exposure is harsh. Future years with inadequate precipitation may cause plantation pines with poorly developed root systems to die.

Armillaria and annosus are two of the most common root diseases in California and usually take about 5-10 years following fires to build up enough inoculum and energy in stumps and roots to then begin spreading to adjacent conifer seedlings. The Cleveland Fire occurred 10 years ago, and the sites we visited were planted 7-8 years ago. Unfortunately, it is not possible to predict how much additional mortality will occur from any of these 3 factors. Spread of root disease from infected plantation pines to healthy plantation pines is not expected. Rather, pine seedling losses should be restricted to the root zone of large infected oaks for Armillaria and large pine stumps for annosus and may continue for the next few years.

Because additional mortality from site conditions and pathogens is expected, it may be advisable to stop pre-commercial thinning activities for several years until this mortality is fully expressed. The alternative is to continue thinning, lose additional pines and be left with inadequate stocking.

BIOLOGIES OF ROOT DISEASE PATHOGENS

Armillaria Root Disease

Fungi in the genus *Armillaria* are widely distributed in soils and usually live as saprophytes on dead wood or other organic matter. Until about 1980, it was thought that only the species *Armillaria mellea* existed in North America. Recent research, however, has shown that nine species may be present. In California, *A. mellea* is the most common species, followed by *A. gallica*. The following discussion refers to *A. mellea*.

This fungus has a wide host range, including virtually all woody plants in California. It is frequently associated with hardwood roots, especially oaks. Healthy oaks are resistant to the fungus. This resistance disappears, however, when trees are weakened, stressed, cut, or killed, and Armillaria may then rapidly colonize and decompose roots and sometimes entire root systems. Stresses that have been linked to increased damage from this root disease include insect defoliation, drought, excessive soil moisture, poor planting techniques, bark beetle attack, air pollution injury, and nutrient deficiencies.

The organic material used as a source of nutrition is called a food base. With a large food base to utilize, the fungus becomes more aggressive and moves to the roots of nearby trees by means of root contacts and rhizomorphs. Rhizomorphs are structures that resemble black shoestrings and grow like roots through upper soil layers. The predominant method of tree to tree spread in California is via root contact; rhizomorphs are more important and prevalent in other areas of the country.

Armillaria is capable of directly penetrating through the intact root bark of living trees, and once it reaches the cambium it usually grows rapidly, producing a flat, white, leathery, fan-shaped mycelial mat under the bark. Rhizomorphs are often associated with the mat. If the fungus reaches the root collar it girdles the stem and kills the tree. After Armillaria successfully colonizes a root segment or root system, it continues to decay the wood and causes a white to yellowish, wet, stringy rot. This rot does not usually extend up the stem more than a few feet above the soil line.

Clusters of mushrooms may be found in the fall at the base of infected dead or dying trees and stumps. These mushrooms may also grow directly out of the soil near the food base. Spores produced by fruiting bodies are not an important source of new infections or long distance spread.

Annosus Root Disease of Pine

Heterobasidion annosum (formerly *Fomes annosus*) is a fungus that attacks a wide range of woody plants, causing decay of the roots and lower bole and death of sapwood and cambium. All pines in California are susceptible; hardwoods are rarely affected.

The fungus becomes established in freshly cut stumps from air-borne spores produced by fruiting bodies (conks). It then grows into the root system and may spread to adjacent healthy trees via root contacts. Infected pines are usually killed rather rapidly when *H. annosum* girdles the root collar. After several years, conks are produced under the bark of dead trees, in decayed stumps, or in the duff at the root collar (only under very wet conditions).

Local spread of *H. annosum* outward from a stump results in the formation of disease centers that have dead trees in the middle and dying trees on the margin. With mature size trees, these centers usually continue to enlarge until they reach barriers such as openings or groups of non-host plants. The fungus may remain alive for as long as 50 years as a saprophyte in infected roots and stumps. Pines can seed in or be planted in centers and survive for a few years, but they eventually will be infected and die.

There are two pathogenic strains of the fungus that differ in their ability to infect various conifers in California. The "P" or pine type infects and kills all pines (although susceptibility of pine species vary), in addition to incense-cedar and western juniper. The "S" or fir type infects true fir and giant sequoia. At this time it is not certain which strain attacks Douglas-fir. Knowing which type is active in a stand will allow favoring alternate conifer species since the strains do not cross infect between the two groups listed above.

United States Department of Agriculture | Forest Service | Stanislaus National Forest | 19777 Greenley Road Sonora, CA 95370

File Code: 3420
Route To: (3000)

Date: July 30, 2002

Subject: Pinyon Pine Branch Sample Evaluation (FHP Report C02-3)

To: Mary A. Wisehart, Special Agent, R5

On July 16, 2002, Dr. John Wenz (Entomologist) and Dr. John Pronos (Plant Pathologist) looked at the pinyon pine branch material you brought in for evaluation. They examined the needles, branches and twigs, including the tissues under the bark and dissected some of the cones.

Most of the injury (partially to completely discolored needles and cones) was to the current years' growth. No evidence was found to indicate that the injury was caused by insect or biological disease agent activity. It is possible that abiotic or environmental factors could have contributed to the damage, but the cause could not be determined.

Please direct any questions to Dr. Wenz or Dr. Pronos.

/s/ Daniel A. Young/s/ Daniel A. Young
DANIEL A. YOUNG
Resource Management PAL

cc: John Wenz, John Pronos